

Remarks

Reconsideration of this Application is respectfully requested.

Claims 1-9 are pending in the application, with claim 1 being the independent claims.

Applicants thank the Examiner for the telephone interview of March 16, 2007. Further to that interview, we provide herein our arguments for his consideration.

Based on the following remarks, Applicants respectfully request that the Examiner reconsider all outstanding objections and rejections and that they be withdrawn.

Rejections of claims 1-7 and 9 under 35 U.S.C. § 103(a)

Claims 1-7 and 9 were rejected under 35 U.S.C. §103(a) as allegedly being unpatentable over Hwang *et al.* (*J. Mater. Chem.* 11:1722-1725 (2001)). Specifically, the Examiner alleged that Hwang describes sonification of a CNT solution for 10 minutes. However, the Examiner acknowledged that Hwang does not provide for an extended sonification period of 2 to 10 hours. Office Action, pg. 2, last ¶. The Examiner alleged that it would have been obvious for one of ordinary skill in the art to optimize the sonification period in order to achieve a homogeneous dispersion of CNTs. For evidence of this allegation, the Examiner alleged that Smalley *et al.* (*J. Nanosci. Nanotech* 3:81-86 (2003)) describes the relationship between sonification time and CNT dispersion for time periods up to 5 hours. Applicants respectfully traverse this rejection.

To establish a *prima facie* case of obviousness, the art cited by the Examiner must (1) teach all of the claim limitations; (2) provide a suggestion or motivation to those of ordinary skill in the art to make the claimed composition; and (3) reveal that one of ordinary skill would have a reasonable expectation of success in doing so. *See In re Vaeck*, 20 USPQ2d 1438, 1442 (Fed. Cir. 1991); *see also* M.P.E.P. § 706.02(j). Claim 1 requires that the carbon nanotubes in the salt dispersion medium of (c) be sonicated for 2 to 10 hours. Claims 2-7 and 9 are dependent on claim 1. As the Examiner has acknowledged, Hwang does not describe for sonication of the dispersion for 2 to 10 hours. In order to provide motivation to sonicate the dispersion for 2 to 10 hours, the Examiner relies on Smalley as a secondary reference to teach all the claim limitations. However, a review of the disclosure of Smalley would not have provided a motivation for sonicating for 2 to 10 hours. In fact, Smalley would have taught away from sonicating for extended periods of time. Examples of these teachings away are highlighted throughout the Smalley article. Some examples of these teachings away from extended sonification times include the following.

First, Smalley notes that "[a]fter each addition of surfactant, the fluorescence intensity rises and *stabilizes to a steady state value over a period of about 20 min to 1 h*, depending on the amount of added surfactant." Pg. 82, col. 2, emphasis added. The rise in intensity correlates with increased debundling of the carbon nanotubes, indicating an increase in dispersion. Thus, Smalley teaches that the dispersion "stabilizes to a steady state value" when sonicated for a period of from 20 minutes to one hour. Since Smalley teaches the debundling reaches a steady state (i.e., no increase in dispersion) at 20

minutes to one hour, one of skill in the art would not have been motivated to sonicate the dispersion of the present invention for over 1 hour, let alone from 2 to 10 hours.

Second, Smalley notes that dispersion (as exemplified by a change in emission or fluorescence) does not occur in the absence of surfactant, stating "[n]o emission is evident at the start of the experiment, *where sonification proceeds in the absence of surfactant*" (pg. 82, bottom of col. 1-top of col. 2, emphasis added) and "[f]luorescence becomes observable during sonification *only with the addition of surfactant*, indicating that the adsorbed phase plays a critical role in the debundling process" (pg 83, col. 2, 3rd paragraph, emphasis added). In view of Smalley, they would have been motivated to add a surfactant, not sonicate for an extended period of time, to increase dispersion. This would also have been consistent with the teaching in Hwang. Thus, Smalley does not provide motivation to sonicate the dispersion of the present invention for 2 to 10 hours.

Third, the experiments performed by Smalley allow Smalley to propose a model for the dispersion process. This model is expressed as mathematical formulae in Equations (1)-(5). None of the variables in Equations (1)-(5) are a function of sonication time. In fact, the rate of change of the concentration of individual nanotubes as a function of time ($\partial C_I / \partial t$) can be found in Equation (2) on page 84, second column:

$$\frac{\partial C_I}{\partial t} = k_z C_b C_{\text{SDS}} - \frac{k_z}{K_{\text{eq}}} C_I$$

wherein k_z is the bundle unzipping rate, C_b is the concentration of bundled nanotubes, C_{SDS} is the concentration of SDS monomer, K_{eq} is the equilibrium constant between individual nanotubes and bundles, and C_I is the concentration of individual nanotubes. Thus, Smalley's own model teaches that the rate of forming individual nanotubes from

bundled nanotubes is a function of surfactant concentration. There is no variable for the function of sonication time. Thus, one of skill in the art would *not* have been motivated to sonicate the nanotubes as described by Hwang for 2 to 10 hours. In fact, Smalley would have taught away from extended sonifications by providing motivation only to alter the surfactant concentration. Thus, Smalley does not provide motivation to sonicate the dispersion of the present invention for 2 to 10 hours.

Fourth, in the Office Action, the Examiner focused his attention on Fig. 2 of Smalley (pg. 82, second col.). The Examiner alleged that Fig. 2 represented the "relationship between sonification time and CNT dispersion in aqueous solutions for time periods up to approximately 5 hours." Office action, pg. 3, first ¶. However, Fig. 2 actually highlights the effects of addition of *surfactants* to the dispersion, since surfactant concentration is increased over time. The Examiner's attention is directed to the Roman numerals located in Fig. 2, representing the addition of additional surfactants. Thus, Fig. 2 describes the increased dispersion of CNTs as a function of *surfactant concentration*, not as a function of *sonification time*. In fact, Fig. 2 demonstrates that for a given surfactant concentration, the rate of dispersion slows to almost equilibrium. This slowed rate of dispersion over time to equilibrium, followed by increased rate of dispersion upon addition of more surfactant, results in the plotted data appearing to be "scalped." Thus, Fig. 2 would have taught one of skill in the art to add surfactant to increase dispersion, and would have taught away from sonicating for 2 to 10 hours. Therefore, Smalley does not provide motivation to sonicate the dispersion of the present invention for 2 to 10 hours.

In view of the fact that the Examiner has acknowledged that Hwang does not provide for an extended sonication period of 2 to 10 hours, and that the secondary reference of Smalley does not teach or suggest the motivation to sonicate for 2 to 10 hours, Applicants submit that the Examiner has failed to establish a *prima facie* case of obviousness. Furthermore, due to the teachings away of Smalley, one of skill in the art would not have a reasonable expectation of success. Upon consideration of the above, Applicants respectfully request that the rejections under 35 U.S.C. § 103(a) with respect to the Hwang in further view of Smalley be withdrawn.

Rejections of claim 8 under 35 U.S.C. § 103(a)

Claim 8 was rejected under 35 U.S.C. §103(a) as allegedly being unpatentable over Hwang *et al.* in further view of Chang (U.S. Pat. No. 6,420,293). Specifically, the Examiner alleges that Hwang teaches that the SiO₂-CNT powder is to be calcinated in an N₂ atmosphere at 1050°C, which falls between the claimed temperature range of 400-1700°C. The Examiner acknowledges that Hwang fails to explicitly set forth that the calcination of the ceramic matrix should be performed under a high vacuum. However, the Examiner alleges that Chang teaches that the heating of carbon nanotube materials at elevated temperatures in an oxidizing environment typically results in chemical changes in the surface of the particles, and that both N₂ atmospheres and high vacuum environments are commonly utilized as non-oxidizing environments. Thus, the Examiner alleges that the high vacuum environment would be an obvious alternative to the nitrogen atmosphere in Hwang. Applicants respectfully traverse this rejection.

To establish a *prima facie* case of obviousness, the cited document(s) must teach or suggest each and every element of the claimed invention. Claim 8 is dependent on claim 1. Claim 1 features that the carbon nanotubes in the salt dispersion medium of (c) be sonicated for 2 to 10 hours. Hwang does not teach or suggest that the salt dispersion be sonicated for 2 to 10 hours. Likewise, Chang does not teach or suggest that the salt dispersion be sonicated for 2 to 10 hours. Thus, neither Hwang nor Chang teach or suggest each and every element of claim 1, either individually or collectively. Since claim 8 is dependent on claim 1, then each and every element of claim 8 is also not taught or suggested. For at least the above argument, and in further view of the arguments for claim 1-7 and 9 filed herein, the rejection of claim 8 under 35 U.S.C. §103 as allegedly being obvious by Hwang *et al.* in view of Chang should be withdrawn.

Conclusion

All of the stated grounds of objection and rejection have been properly traversed, accommodated, or rendered moot. Applicants therefore respectfully request that the Examiner reconsider all presently outstanding objections and rejections and that they be withdrawn. Applicants believe that a full and complete reply has been made to the outstanding Office Action and, as such, the present application is in condition for allowance. If the Examiner believes, for any reason, that personal communication will expedite prosecution of this application, the Examiner is invited to telephone the undersigned at the number provided.

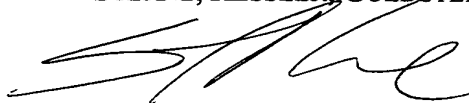
Reply to Office Action of January 3, 2007

HONG *et al.*
Appl. No. 10/780,863

Prompt and favorable consideration of this Reply is respectfully requested.

Respectfully submitted,

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